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ALTERING THE MAGNITUDE OF DELAY DISCOUNTING BY PATHOLOGICAL GAMBLERS

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The present study explored the delay discounting of future and past monetary rewards by pathological gamblers. Using a multiple baseline design, following repeated exposure to choices between smaller immediate and larger delayed consequences, participants completed a relational responding task that attempted to alter the psychological functions of irrelevant stimuli and to affect subsequent delay discounting. Results support previous literature on the discounting of delayed consequences by pathological gamblers, illustrate that the discounting of past rewards occurs in a similar fashion to the well-documented literature on the discounting of future rewards, and that magnitude of discounting can be altered.

DESCRIPTORS: addiction, choice, delay discounting, pathological gambling, self-control

Behavior-analytic explorations of pathological gambling have begun only recently, even though an exponential rise in pathological gambling has occurred during the past 20 years (Petry, 2004; Weatherly & Dixon, 2007). Recent behavior-analytic research has shown that pathological gamblers appear to discount delayed monetary consequences to a greater degree than nonpathological gamblers (Dixon, Marley, & Jacobs, 2003), and that pathological gamblers will discount delayed monetary consequences to a greater degree when in a gambling context than when outside that context (Dixon, Jacobs, & Sanders, 2006). For example, if given choices between various dollar amounts available now (ranging from $1 to $1,000) versus $1,000 in 1 week, pathological gamblers tend to make more choices for the various smaller amounts of money now rather than waiting for the $1,000 in a week (Dixon et al., 2003, 2006).

When such choice data are analyzed at different delay values (e.g., weeks, months, years), a consistent trend emerges. Specifically, as delays to the larger reinforcer increase, choices for this option decrease (Dixon et al., 2003). However, it remains to be seen if pathological gamblers' choices between smaller and larger reinforcers, hypothesized to have been available in the past, will resemble known patterns of choice making shown for future rewards of smaller and larger magnitudes. In therapy situations, pathological gamblers often recall prior bad choices they have made and strategies are put in place for how to make better decisions in the future (Petry, 2004). Due to the fact that many pathological gamblers reflect back on their poor choices that led to their current undesirable financial situation, explorations of past choice making are warranted.

When exposed to experimental preparations that simulate actual casino gambling, many gamblers' behavior is orderly and predictable based on programmed contingencies, rules delivered to the gambler, self-generated rules, or a combination of the three sources of control (see Dixon & Delaney, 2006, for a discussion). In an attempt to merge the literature of relational responding with the clinical concern of pathological gambling, Zlomke and Dixon (2006) allowed recreational slot-machine gamblers to play freely between two slot machines of equal payouts and assessed response allocation.

This study was conducted in partial fulfillment of the master's degree in behavior analysis and therapy by the second author under direction of the first author.

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Following a baseline period, the experimenters trained participants on a series of conditional discriminations. Next, tests were conducted that attempted to establish the colors of the slot machines into relational networks of greater than and less than. After reexposure to the slot-machine task, responding on the slot machine that was of the color recently established in the stimulus network of greater than increased relative to baseline conditions. In summary, responding between two choice options was altered indirectly via conditional discrimination training and testing while the programmed contingencies of the actual slot machines remained exactly the same. Similar results were obtained by Hoon, Dymond, Jackson, and Dixon (2007, 2008). It remains to be seen if such alterations in responding via conditional discrimination training may hold true for gamblers who complete delay-discounting tasks, which involve repeated choices for hypothetical monetary amounts of varying value.

Thus, the present study explored the future and past delay discounting of pathological gamblers over repeated exposures to a delay-discounting task that consisted of choices between past and future rewards before and after completing a conditional discrimination training procedure. This training procedure was designed to alter the functional properties of once-neutral stimuli associated with the choice options for smaller and larger reinforcers.

METHOD

Participants

Five pathological gamblers with no expressed interest in seeking treatment served as participants. The experimenter recruited them through personal contacts and undergraduate classes at the local university. All participants were at least 18 years of age, were paid $30 at the completion of the study, and scored as having a possible gambling addiction on the South Oaks Gambling Screen, which has been shown to be reliable and valid for diagnosing pathological gambling (Lesieur & Blume, 1987). The experimenter instructed the participants to read and sign an informed consent stating the purpose, risks, and benefits of the experiment. The experimenter informed the participants that they were able to withdraw from the experiment at any time.

Setting, Apparatus, and Stimulus Materials

Each participant was seated at a desk in front of a laptop computer that featured a mouse, full-color screen, and a keyboard. A computer programmed in Visual Basic 2005 controlled the presentation of the delay-discounting procedure choice options, stimuli, and data collection. Stimuli consisted of nine graphical images (approximately 5 cm by 5 cm).

Experimental Design and Variables

A nonconcurrent multiple baseline design across participants was used in the current study. The independent variable was the implementation of a conditional discrimination training procedure. The dependent variables were the degree of delay discounting by each participant in each experimental session (calculated using the formula for area under the curve [AUC], explained below) and the training and testing data generated by the conditional discrimination training and testing phase.

Procedure

After entering the room, the experimenter asked the participant to sit in front of the computer monitor and then read the specific instructions for each phase of the experiment to the participant prior to beginning. The experimenter answered all questions before leaving the room, and then a written prompt appeared on the screen instructing the participant to press start to begin the experiment.

Baseline: Delay-discounting pretest. Prior to baseline, the experimenter presented participants with the following instructions:

> Today you are going to be given some choices about money. You will not be receiving the money, but

> please make choices as though you will be receiving the money. The computer image on the left side of the screen reveals money that you can have today. The image on the right side of the screen represents money that you can get after a period of time has passed. Now you are being asked to choose between $1,000 delivered today versus $1,000 that would be given 1 week from today. Use the mouse to choose the reward you would rather have. These types of questions will be asked multiple times about different monetary amounts so keep making selections based on the reward you would rather receive.

All hypothetical monetary choices were made using the computer mouse to point to an amount of money displayed on the computer screen. The delays for the experiment were 1, 4, 12, 24, 52, 156, and 520 weeks.The hypothetical monetary rewards were $1,000, $990, $960, $920, $850, $750, $700, $650, $600, $550, $500, $450, $400, $350, $300, $250, $200, $150, $100, $80, $60, $40, $20, and $10 and were presented in a descending order (high to low values).These amounts and delays have been used previously in the study of delay discounting (e.g., Dixon et al., 2003, 2006; Rachlin, Raineri, & Cross, 1991), and the test–retest reliability of the procedure has been demonstrated (Lagorio & Madden, 2005).

The computer screen was arranged such that the column representing sooner smaller was represented by a purple square and the word ''now.'' The later larger column was represented by a pink square and the word ''later'' (or ''ago'' when past discounting occurred). These colored squares surrounding the text were used as potential contextual cues during the conditional discrimination portion of the study. The experimenter asked each participant to complete a series of choices involving the seven delay values over time, with choices about the future and choices about the past randomized in order of presentation across sessions. Sessions required approximately 1 hr to complete, and the number of sessions varied across participants in a multiple baseline fashion.

The delay-discounting task involved a series of choices between the hypothetical monetary amounts and delays about the future and similar choices for the past. Past monetary values were the same as those used in the future discounting task, and the delay time frames were identical in actual time; however, they were presented in past tense (e.g., a week ago, a month ago).

The AUC (see Results below) provided a theoretically neutral metric, quantifying each participant's choices between the sooner smaller monetary amount and the larger delayed monetary amount. AUC values were visually inspected for stability prior to a participant entering into the next phase, except with Participant 1 who entered immediately after one session.

Conditional Discrimination Training

Stimulus sets were chosen that incorporated quantitative gambling stimuli (playing cards), monetary values (dollar bills and coins), nonmonetary quantitative stimuli (letter grades used in American education systems), and nonmonetary qualitative stimuli. Thus, the stimuli could be related to different concepts involving ranking, value, or size similar to those used by Zlomke and Dixon (2006). Figure 1 displays the stimuli used in the study and illustrates a difference in categorical scale (better than or worse than).

The following instructions were presented on the computer screen:

> You are going to see five images on the screen in front of you. Your job is to choose one of the three images on the bottom of the screen by clicking on it with the mouse. When you are correct you will hear a chime sound and the word ''correct'' will appear on the screen for 1 second. When you are incorrect you will see the word ''wrong'' on the screen for 1 second with a ''beep'' auditory sound. There will be a section of the experiment where no feedback will be provided. The computer is still keeping track of your responses so continue to pay attention. The more correct responses made, the quicker you will finish the experiment. Do you have any questions?

The experimenter answered any additional questions, repeated important aspects of the instructions, then left the room after he or she answered all questions.

The tasks for the matching-to-sample pretraining and training were presented as follows

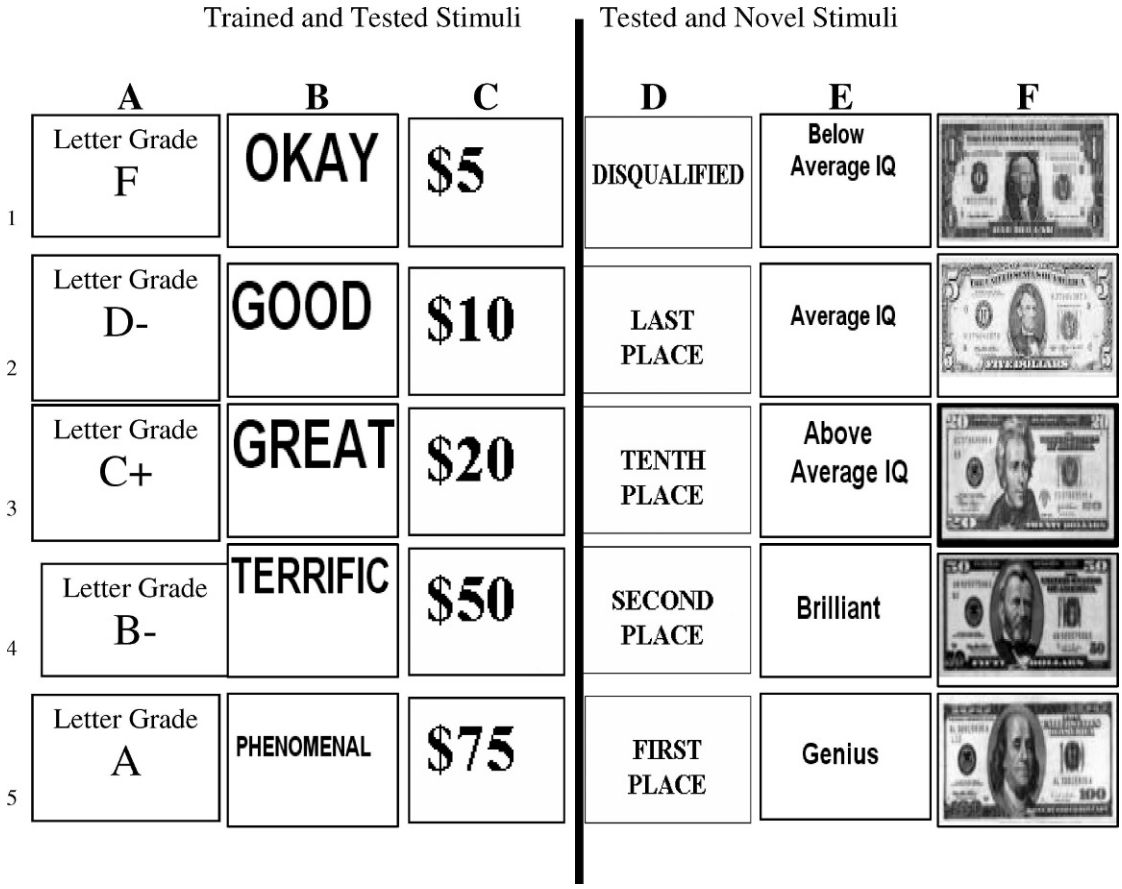

Figure 1. Stimulus sets used during conditional discrimination training.

and constituted a single trial: The contextual stimulus appeared in the upper left corner of the screen first. Then after a 2-s delay, the sample appeared in the center top half of the screen. Next, 2 s after the sample appeared and while it remained on the screen, three comparison stimuli appeared at the bottom of the screen.

Training worse than. The purple contextual cue was presented on all trials. A response to the comparison that was worse than the sample stimulus resulted in the positive programmed consequences (chime and the word ''correct'' on the screen), and a response to the comparison that was better than the sample stimulus resulted in the negative programmed consequences (beep and the word ''wrong'' on the screen). For example, if presented with the letter grade C+, the correct response would be D− instead of A or B. This condition ended following a block of 18 trials in which the participant scored 16 correct responses within one block of 18 trials.

Training better than. The pink contextual cue was presented on all trials. A response to the comparison that was better than the sample stimulus resulted in the positive programmed consequence, and a response to the comparison that was worse than the sample stimulus resulted in the negative programmed consequence. For example, if presented with the letter grade C−, the correct response would be C instead of F or D. As before, this condition ended following a block of 18 trials in which the participant scored 16 correct responses within one block of 18 trials.

Training mixed better than/worse than simultaneously. During this condition, there were 36 intermixed better than (pink) and worse than (purple) trials, which were presented an equal number of times (18). The stimuli (A, B, and C) were displayed randomly 12 times each within a 36-trial block. The criterion to terminate this condition was 32 correct responses within one block of 36 trials.

Testing better than/worse than with no feedback. A 54-trial responding test with no programmed consequences for correct or incorrect responding was conducted, consisting of stimuli used in the prior training conditions as well as the three novel sets of stimuli shown in Figure 1. The test condition was included to assess for transfer of contextual control of the relations better than and worse than. Participants were required to make at least 48 correct responses during the test. Failure to do so resulted in another exposure to the mixed training up to two more times before being dismissed from the study.

Delay-Discounting Posttest

The same conditions and contingencies of baseline were reintroduced to all participants. At this time it was expected that the purple and pink boxes that came to function as contextual cues for worse than and better than in the conditional discrimination task would now affect participants' choices on the now and later response options of the delay-discounting procedure. To review, the now option (sooner smaller) was the same color as the worse than contextual cue during conditional discrimination task, and later ago was the same color as the better than contextual cue.

RESULTS AND DISCUSSION

Research at the individual participant level was analyzed with the metric known as AUC, which allows an interpretation of discounting free of the a priori assumptions of the free *k* parameter of hyperbolic equations often found in this research area (Myerson, Green, & Warusawitharana, 2001). AUC values range from 0 to 1, with larger values indicative of less discounting. Considering that AUC allowed superior data analysis compared to the hyperbolic metric in two previous studies of discounting by pathological gamblers (Dixon et al., 2003, 2006), it served as the sole equation for analysis of the current data set.

To calculate this metric, the dollar amount and the various delay values at which the participant switched from choosing the larger later reinforcer to the smaller immediate reinforcer (often termed the *subjective value*) were identified. Then, the identified value for the switching point for each category (money and weeks) was divided by the largest possible value for that category. In the current investigation, $1,000 (the largest dollar amount) and 520 weeks (the largest delay) were the denominators for each equation, which yielded values between 0 and 1. Next, the following equation was computed:

$$\sum \{(x2 - x1)[(y1 + y2)/2]\},$$

where $x1$ and $x2$ are successive delays (e.g., 1 week and 1 month or 6 months and 12 months), and $y1$ and $y2$ are the subjective values of those delays. If a participant chose the $1,000 later option for all choices presented, the AUC would be 1, and if he or she chose the smaller immediate option for all choices, the AUC would be 0.

Figure 2 displays each participant's AUC values during baseline and posttraining for both future and past discounting tasks. All participants' selections initially produced low AUC values during baseline. With a history of conditional discrimination training of the relations of better than and worse than, AUC values increased for all participants. The same pattern of responding held true for both the traditionally used discounting of future rewards and the unexplored task of discounting of past rewards. Although the trend change in both types of discounting was similar, the past tended to be discounted slightly less for all

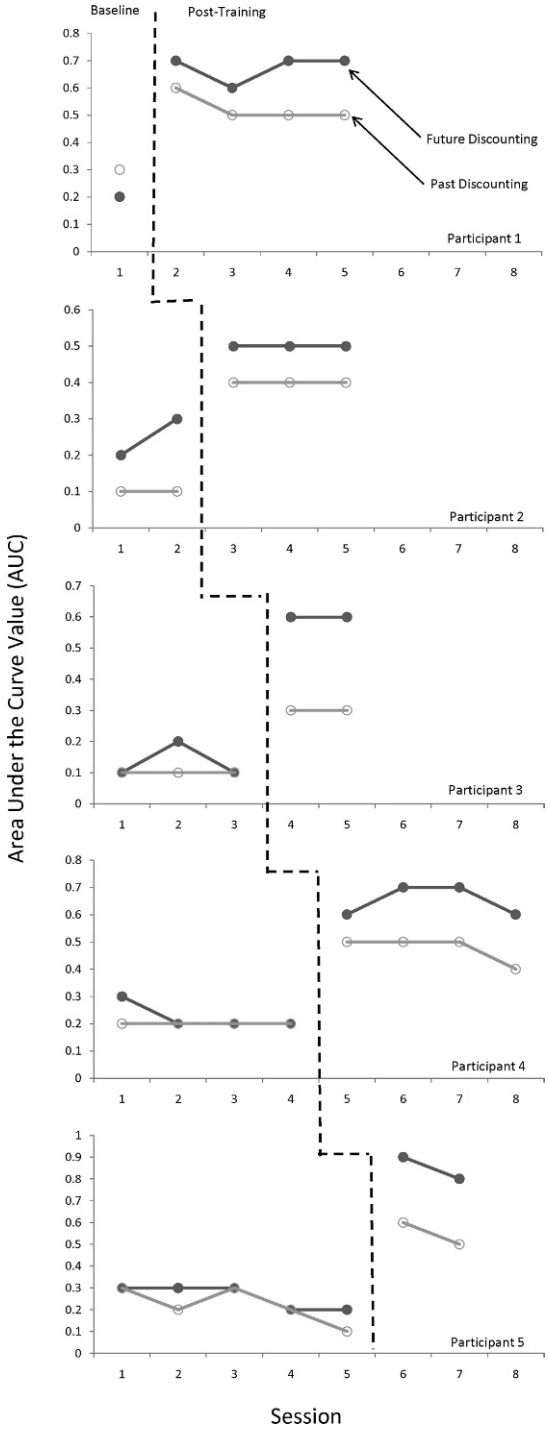

Figure 2. Area under the curve (AUC) for each participant during baseline and posttraining. Data are depicted for both future and past delay discounting. Each participant's *y*-axis value is scaled individually.

participants. In summary, all participants tended to discount the future as they did the past, and both types of discounting occurred less often following conditional discrimination training and testing, thus supporting the notion that such training alters subsequent response allocation (Zlomke & Dixon, 2006). The training was completed by all 5 participants within two-trial blocks consisting of nine trials per block, and test performance ranged between 90% and 100%, eliminating the need for any participant to be retrained and retested.

The present study raises some questions that may guide future research. The slightly lower levels of discounting that occurred for past discounting should be explored further, because they do not fully support claims that the two types of discounting are nearly identical (Yi, Gatchalian, & Bickel, 2006). Perhaps, as pathological gamblers reflect back on the poor decisions made with money in the past, they preferred to have that money back (i.e., choosing the larger past delayed amount rather than the immediate smaller amount). Whether they chose the money to make a better investment or to gamble again remains unanswered. Future research could incorporate additional questioning beyond the discrete choices made in the present experiment. The degree to which changes in responding before and after conditional discrimination training were under exclusive control of the colored contextual stimuli, and if, in fact, a preference for delayed reinforcement actually had been altered, also remain unclear. A future study might incorporate a follow-up condition in which the colored stimuli of the delay-discounting posttest are removed and subsequent response allocation is evaluated.

In summary, the present data support the findings of Dixon et al. (2003, 2006) that have shown that persons who gamble discount delayed consequences in a relatively monotonic fashion. The present study extends the previous

literature by illustrating that discounting of past outcomes may in fact resemble the discounting of future outcomes, and that the degree of discounting appears to remain relatively constant over the few repeated assessments conducted in the present study. The current methods may be useful as the foundation for a clinical assessment technique along with a potential intervention that incorporates reflecting back upon poor choices made in the past and if done today, what should be done differently. With the ever-increasing popularity, availability, and participation in legalized gambling, behavior-analytic understanding of the behavior of its addicts is desperately needed.

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